

**ADDENDUM NO. 1  
TO THE  
EXPANDED ENGINEERING EVALUATION AND COST ANALYSIS  
FOR THE  
FROHNER MINE AND MILL SITE  
CLANCY-LUMP GULCH MINING DISTRICT, JEFFERSON COUNTY, MONTANA  
DEQ Contract: 407026 Task Order: 015**



*Aerial Photo Frohner Mine and Mill Site -2005*

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March 2008

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## **1.0 INTRODUCTION**

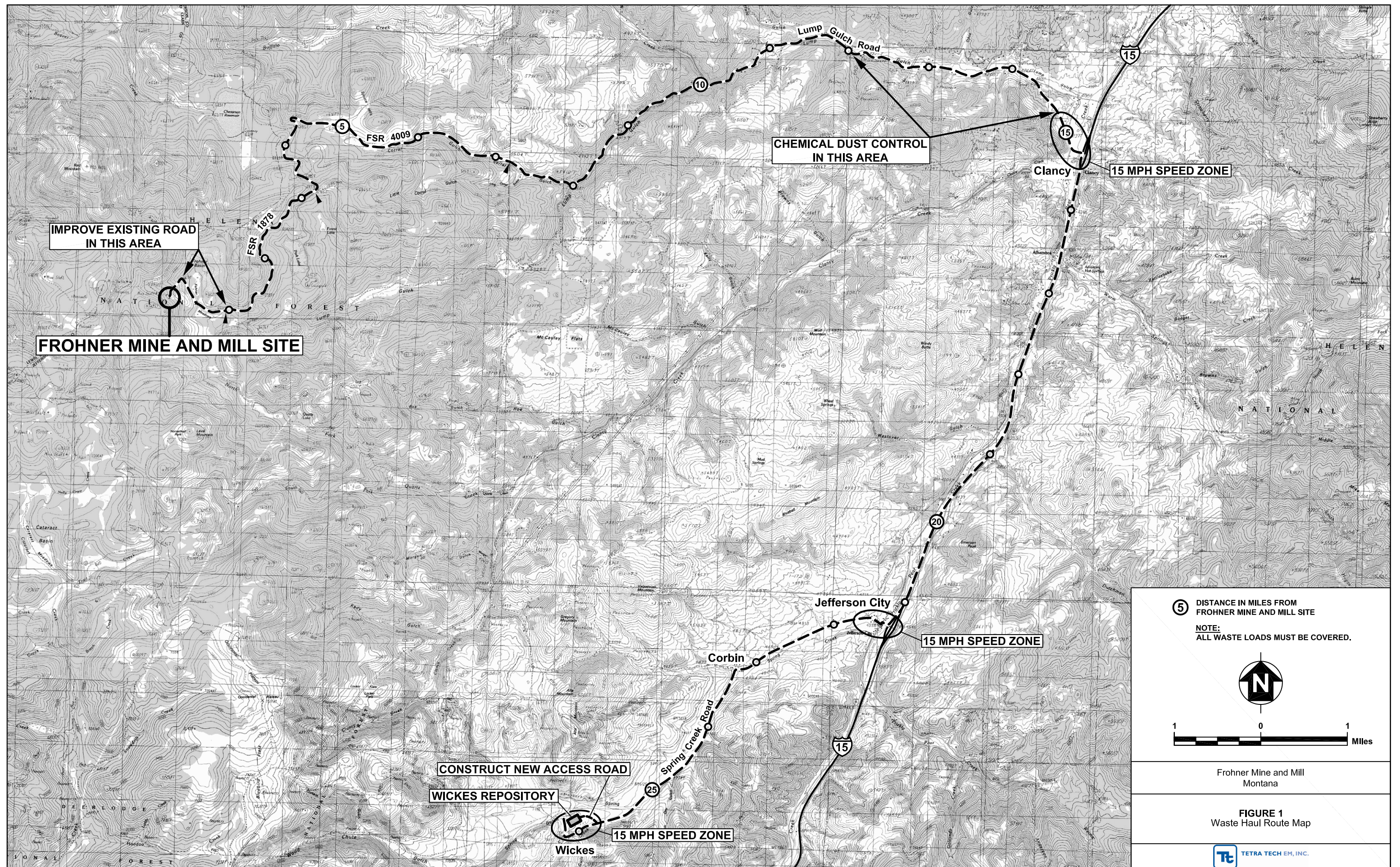
Pursuant to Contract No. 407026 Task Order 015, the Montana Department of Environmental Quality's Mine Waste Cleanup Bureau (MDEQ/MWCB) retained Tetra Tech to prepare an addendum to the expanded engineering evaluation and cost analysis (EEE/CA) for the Frohner Mine and Mill Site. The Frohner Mine and Mill site is located 9 miles southwest of Clancy, Montana in Sections 14 and 15, Township 8 North, Range 5 East, Montana principle meridian in Jefferson County, Montana. Mine wastes at the site include both waste rock and mill tailings. The purpose of this EEE/CA addendum is to address two additional reclamation alternatives for removal and disposal of mine and mill waste from the Frohner Mine and Mill site.

The two new alternatives include hauling mine and mill wastes from the Frohner Mine and Mill site about 26 miles to a parcel of Bureau of Land Management land located north of the community of Wickes (Figure 1). The haul route would run east from the mine site down Lump Gulch to the community of Clancy, then south along Interstate Highway 15 to the community of Jefferson City, then southwest along Spring Creek Road to the Wickes repository site. About 5,000 feet of the proposed haul road just below the mine will require improvement to allow the use of highway tandem axle dump trucks. Roughly 15,000 feet of the Lump Gulch Road immediately west of Clancy will require treatment with magnesium chloride to minimize road dust through this residential area. A new access road approximately 2,500 feet in length will be constructed from Spring Creek Road to the repository site to eliminate the need to haul waste through the Wickes townsite.

As part of Alternative 8A the mine and mill wastes would be placed in a stand alone repository located adjacent to the existing Wickes mine and smelter repository. This new repository would be lined with a multi-layer membrane bottom liner and covered with a membrane and cover soil cap. As part of Alternative 8B the mine waste would be placed on top of the existing Wickes mine and smelter repository and covered with a new multi-layer membrane and soil cap.

The preferred reclamation alternative for the Frohner Mine and Mill site, as identified in the 2000 EEE/CA (Pioneer 2000), is Alternative 5c. This alternative included partial in-place waste containment and partial waste removal and placement in an on-site repository. The location of the proposed on-site repository was about three quarters mile southwest of the mine site in a relatively level saddle astride the Lewis and Clark County and Jefferson County lines. Access to the proposed repository site would have required the construction of a haul road through steep timbered country up hill of the mine site.







## **2.0 FROHNER MINE AND MILL DESCRIPTION AND CHARACTERIZATION**

A detailed cultural resource inventory and assessment for the Frohner Mine and Mill site was prepared for MDEQ by GCM Services, Inc. (October 1998). While mining claims were located in the Frohner area as early as 1872, significant development did not occur at the Frohner Mine until the late 1880s.

However, major mining activity at the site was limited to two periods; the first in 1911 and the second in 1928 and 1929. The lower adit is estimated to comprise over 2,000 feet of horizontal workings that are now caved in. Early metals production from the mine is unknown. From 1928 through 1954 the mine is credited with the production of 161 ounces of gold, 7,320 ounces of silver, 2,305 pounds of copper, 91,503 pounds of lead, and 26,000 pounds of zinc from 1,917 tons of ore.

Topography at the mine site is steep and mountainous with elevations at the site ranging from approximately 7,200 to 7,400 feet. The site is cool and dry with a continental-dominated climate. Precipitation averages between 18 to 20 inches per year with most falling as snow during the fall and winter period. The area is generally covered with snow from November through May.

The mine site includes three separate mining claims: the Frohner, the Frohner Extension, and the Loeber. There are six waste rock dumps, one mill tailings pile, numerous streamside tailings deposits, two discharging adits, and miscellaneous deteriorated structures scattered over the three mining claims. The total volume of mine waste was estimated in the EEE/CA at 8,400 cubic yards (CY) of which 500 CY are tailings. Most of the mine waste is located on private land, but some of the waste rock dumps have spilled over onto Forest Service property. One waste rock dump (WR1) associated with the mine site (500 CY) is located entirely on Forest Service property.

Contaminants of concern in waste rock and tailings samples collected at the site include antimony, arsenic, copper, lead, mercury, silver, and zinc. Peak concentrations of these metals within the samples are as follows:

- Antimony: 90.2 milligrams per kilogram (mg/kg) in the waste rock (WR3) and 23.3 mg/kg in the tailings
- Arsenic: 28,000 mg/kg in the waste rock (WR3) and 14,500 mg/kg in the tailings
- Cadmium: 6.7 mg/kg in the waste rock (WR3) and 4.5 mg/kg in the tailings
- Copper: 160 mg/kg in the waste rock (WR2) and 165 mg/kg in the tailings
- Lead: 35,900 mg/kg in the waste rock (WR3) and 9,510 mg/kg in the tailings
- Mercury: 1.2 mg/kg in the waste rock (WR3) and 1.4 mg/kg in the tailings
- Silver: 16.2 mg/kg in the waste rock (WR3) and 35.9 mg/kg in the tailings
- Zinc: 316 mg/kg in the waste rock (WR3) and 470 mg/kg in the tailings



Surface water sampling at the site indicates arsenic cadmium, copper, iron, manganese, lead, and zinc are present at levels in excess of Montana water quality standards in the discharge water from Adit 2 and in water flowing off of the site.

A human health risk assessment was completed as part of the original EEE/CA (Pioneer 2000). This risk assessment determined that both arsenic and lead levels at the site present an unacceptable non carcinogenic risk to human health and that arsenic levels at the site present an unacceptable carcinogenic risk to human health. An ecological risk assessment was also completed as part of the EEE/CA. This risk assessment determined that arsenic, cadmium, copper, lead and zinc levels at the site present an unacceptable risk to the environment.

Based on the EEE/CA risk assessment and Applicable or Relevant and Appropriate Requirements (ARAR) for the site, cleanup goals were developed that require a 92.2 percent reduction in arsenic levels to 646 mg/kg and a 51.2 percent reduction in lead levels to 2,200 kg/mg at the Frohner Mine and Mill site (Pioneer 2000).

### **3.0 COMPARISON OF RECLAMATION ALTERNATIVES**

This section includes a brief evaluation of two additional reclamation alternatives for the Frohner Mine and Mill site. This evaluation includes a comparison of the two alternatives relative to the seven evaluation criteria used in the EEE/CA, including costs. A No-Action alternative was already proposed in the original EEE/CA and is not discussed here. The reclamation activities conducted under both alternatives are similar except for the location of the mine waste repository and the containment features of the repository.

Under Alternative 8A, the mine and mill wastes would be placed in a stand alone repository located adjacent to the existing Wickes mine and smelter repository. This new repository would be lined with a multi-layer membrane bottom liner consisting of a geosynthetic clay liner (GCL) overlain by a geocomposite drainage layer (GDF) and covered with a multi-layer membrane and cover soil cap. Alternative 8A would also require a leachate collection system. As part of Alternative 8B, the mine waste would be placed on top of the existing Wickes mine and smelter waste repository (after a portion of the existing cover soil was salvaged) and covered with a new multi-layer membrane and soil cap.



Important design parameters for the two alternatives are the following:

Alternative 8A: Stand alone repository with a bottom liner and top cap.

- Waste volume: 10,000 CY
- Waste haul distance: 26 miles
- Haul road improvement: 5,000 feet
- Haul road dust control chemical application: 15,000 feet
- Repository access road improvement: 2,500 feet
- Repository area: 0.9 acres (approximately 200 feet square)
- Depth of waste: 8 feet
- Repository excavation: 6,000 CY
- Leachate collection piping: 400 lineal feet
- Leachate collection drain gravel: 150 CY
- Leachate transmission piping: 150 lineal feet
- Geosynthetic clay membrane: 9,000 square yards (liner and cap)
- Geocomposite drainage fabric: 9,000 square yards (liner and cap)
- Cover soil volume: 3,000 CY
- Total revegetation area: = 2 Acres

Alternative 8B: Waste placed on top of existing repository and new top cap

- Waste volume: 10,000 CY
- Waste haul distance: 26 miles
- Haul Road Improvement: 5,000 feet
- Haul road dust control chemical application: 15,000 feet
- Repository access road improvement: 2,500 feet
- Repository area: 6.0 acres (approximately 500 feet square)
- Depth of waste: 3 feet at maximum tapering to 6 inches at edge of repository
- Existing cover soil salvage: 8,000 CY (1 foot thick)
- Geosynthetic clay membrane: 24,000 square yards (cap only)
- Geocomposite drainage fabric: 24,000 square yards (cap)
- Additional cover soil volume: 8,000 CY (additional 1 foot thick)
- Total revegetation area: = 6 Acres

The estimated cost of alternative 8A is shown in Table 1 and the estimated cost of alternative 8B is shown in Table 2. Unit costs used to estimate the cost of the two alternatives are based on professional judgment and recent bids for similar work at the other Montana abandoned mine reclamation projects. The difference in the cost of the two alternatives is primary due to the additional membrane and cover soil needed to cap the larger existing Wickes repository. Table 3 lists the ability of each alternative to meet the threshold criteria and the primary balancing criteria.



**TABLE 1**  
**COST ESTIMATE - ALTERNATIVE 8A**  
**OFF-SITE DISPOSAL – STAND ALONE MODIFIED RCRA REPOSITORY**

Cost Item	Quantity	Unit	Unit Cost (\$)	Cost (\$)
Capital Costs				
Mobilization, Bonding & Insurance	1	LS	\$40,000.00	\$40,000.00
Mine Site Preparation and Storm Water Control	3	AC	\$1,000.00	\$3,000.00
Access Road Improvement	5000	LF	\$5.00	\$25,000.00
Haul Road Dust Control	15,000	LF	\$1.00	\$15,000.00
Waste Excavation	10,000	CY	\$2.00	\$20,000.00
Waste Hauling, Placement, and Compaction	10,000	CY	\$30.00	\$300,000.00
Mine Site Cover Soil - 12 Inches	2,000	CY	\$30.00	\$60,000.00
Mine Site Revegetation	3	AC	\$2,000.00	\$6,000.00
Farm Fence	2,000	LF	\$10.00	\$20,000.00
Debris Disposal	50	Tons	\$100.00	\$5,000.00
Repository Access Road	2,500	LF	\$10.00	\$25,000.00
Repository Excavation	6,000	CY	\$3.00	\$18,000.00
Bottom Liner, GCL and GDF	4500	SY	\$10.00	\$45,000.00
Leach Collection System, Pipe and Gravel	400	LF	\$10.00	\$4,000.00
Leachate Disposal System	1	LS	\$5,000.00	\$5,000.00
Top Cap GCL and GDF	4500	SY	\$10.00	\$45,000.00
Repository Cap Cover Soil -24" Thick	3,000	CY	\$10.00	\$30,000.00
Repository Site Revegetation	3	AC	\$2,000.00	\$6,000.00
Chain Link Fence	200	LF	\$25.00	\$5,000.00
Cleanup and Demobilization	1	LS	\$5,000.00	\$5,000.00
Subtotal Construction Costs				\$682,000.00
Construction Contingencies		15 % of Construction Cost		\$102,300.00
Engineering Design and Construction Oversight		15 % of Construction Cost		\$102,300.00
Total Capital Costs				\$886,600.00
Yearly Operation and Maintenance (O&M) Costs				
Site Inspections	3	EA	\$500.00	\$1,500.00
Site Maintenance		1 % of Construction Cost		\$6,820.00
Subtotal O&M Costs				\$8,320.00
O&M Contingencies		15%		\$370.00
Total Yearly O&M Cost				\$8,690.00
Present Worth of O&M Costs Based on 30 Year Life @ 7.00%		PF Factor = 12.41		\$107,842.90
Total Present Worth				\$994,442.90

Notes: AC = Acre      CY = Cubic Yard      LF = Lineal Feet  
LS = Lump Sum      SY = Square Yard      PF = Present Worth Factor

**TABLE 2**  
**COST ESTIMATE – ALTERNATIVE 8B**  
**OFF-SITE DISPOSAL – WASTE PLACED ON TOP OF EXISTING WICKES REPOSITORY**

Cost Item	Quantity	Unit	Unit Cost (\$)	Cost (\$)
Capital Costs				
Mobilization, Bonding & Insurance	1	LS	\$40,000.00	\$40,000.00
Mine Site Preparation and Storm Water Control	3	AC	\$1,000.00	\$3,000.00
Access Road Improvement	5000	LF	\$5.00	\$25,000.00
Haul Road Dust Control	15,000	LF	\$1.00	\$15,000.00
Waste Excavation	10,000	CY	\$2.00	\$20,000.00
Waste Hauling, Placement, and Compaction	10,000	CY	\$30.00	\$300,000.00
Mine Site Cover Soil - 12 Inches	2,000	CY	\$30.00	\$60,000.00
Mine Site Revegetation	3	AC	\$2,000.00	\$6,000.00
Farm Fence	2,000	LF	\$10.00	\$20,000.00
Debris Disposal	50	Tons	\$100.00	\$5,000.00
Repository Access Road	2,500	LF	\$10.00	\$25,000.00
Cover Soil Salvage	8,000	CY	\$1.00	\$8,000.00
Top Cap GCL and GDF	4500	SY	\$10.00	\$45,000.00
Repository Cap Cover Soil -12" Salvaged Soil	8,000	CY	\$2.00	\$16,000.00
Repository Cap Cover Soil -12" New Borrow	8,000	CY	\$12.00	\$96,000.00
Repository Site Revegetation	5	AC	\$2,000.00	\$10,000.00
Cleanup and Demobilization	1	LS	\$5,000.00	\$5,000.00
Subtotal Construction Costs				\$699,000.00
Construction Contingencies		15 % of Construction Cost		\$104,850.00
Engineering Design and Construction Oversight		12 % of Construction Cost		\$83,880.00
Total Capital Costs				\$887,730.00
Yearly Operation and Maintenance (O&M) Costs				
Site Inspections	3	EA	\$500.00	\$1,500.00
Site Maintenance		1 % of Construction Cost		\$6,990.00
Subtotal O&M Costs				\$8,490.00
O&M Contingencies		15%		\$370.00
Total Yearly O&M Cost				\$8,860.00
Present Worth of O&M Costs Based on 30 Year Life @ 7.00%		PF Factor = 12.41		\$109,952.60
Total Present Worth				\$997,682.60

Notes:    AC = Acre                      CY = Cubic Yard                      LF = Lineal Feet  
                   LS = Lump Sum                      SY = Square Yard                      PF = Present Worth Factor



**TABLE 3**  
**COMPARATIVE ANALYSIS OF REPOSITORY ALTERNATIVES**

<b>Assessment Criteria</b>	<b><u>Alternative 8A</u></b> Excavation and Off-Site Disposal in Stand-Alone Repository	<b><u>Alternative 8B</u></b> Excavation and Off-Site Disposal on Top of Wickes Repository
<b>Overall Protectiveness</b>		
<i>Public Health, Safety, and Welfare</i>	Exposures expected to be eliminated.	Exposures expected to be eliminated.
<i>Environmental Protectiveness</i>	Exposures expected to be eliminated.	Exposures expected to be eliminated.
<b>Compliance with ARARs</b>		
<i>Chemical-Specific</i>	Chemical-specific ARARs would be met.	Chemical-specific ARARs would be met.
<i>Location-Specific</i>	Location-specific ARARs would be met.	Location-specific ARARs would be met.
<i>Action-Specific</i>	Action-specific ARARs would be met.	Action-specific ARARs would be met.
<b>Long-Term Effectiveness and Permanence</b>		
<i>Magnitude of Residual Risk</i>	Contaminated materials removed from site.	Contaminated materials removed from site. Risk reduction similar to alternative 8A.
<i>Adequacy and Reliability of Controls</i>	Waste removed from site. Reliability of waste repository is dependent, in part, upon long-term maintenance.	Waste removed from site. Reliability of waste repository is dependent, in part, upon long-term maintenance. Similar reliability as alternative 8A.
<b>Reduction of Toxicity, Mobility, and Volume through Treatment</b>		
<i>Treatment Process Used and Materials Treated</i>	No treatment process.	No treatment process.
<i>Volume of Contaminated Materials Treated</i>	No treatment process.	No treatment process.
<b>Short-Term Effectiveness</b>		
<i>Protection of Community During Reclamation Action</i>	Fugitive emissions control may be required during construction.	Similar to alternative 8A.
<i>Protection of On-Site Workers During Removal Action</i>	Expected to be sufficient. Safety associated with waste excavation and long truck haul likely more prevalent than hazards associated with wastes.	Similar to alternative 8A.
<i>Time Until Removal Action Objectives are Achieved</i>	One field season.	One field season.
<b>Implementability</b>		
<i>Ability to Construct and Operate</i>	Some difficulties expected with long distance haul and truck traffic through Clancy and Jefferson City.	Some difficulties expected with long distance haul and truck traffic through Clancy and Jefferson City.
<i>Ease of Implementing More Action if Necessary</i>	Waste materials not readily accessed without destroying cap and liner. Other actions easily implemented such as additional armoring/ stabilization, or other methods.	Similar to alternative 8A.
<i>Availability of Services and Capacities</i>	Available locally and within the state.	Available locally and within the state.
<i>Availability of Equipment and Materials</i>	Available locally and within the state.	Available locally and within the state.
<b>ESTIMATED TOTAL PRESENT WORTH COST</b>	\$ 994,400	\$997,700

Both alternatives are considered protective of human health and the environment because wastes would be effectively isolated in either the new stand alone repository or the modified existing repository. The repositories would isolate the mine wastes from contact with potential receptors, and would reduce the potential for dust inhalation and off-site exposure via erosion. Both alternatives would comply with ARARs by isolating the contaminated materials from contact with potential receptors, reducing releases to surface water, and reducing the potential for leaching of metals into groundwater.

Alternative 8A is less expensive than alternative 8B. The present worth cost of alternative 2 is \$994,400 and the present worth cost of alternative 3 is \$997,700, a difference of \$3,300 or less than one percent. The difference in the cost of the two alternatives is primarily due to the additional membrane and cover soil needed to cap the larger existing Wickes repository. However, under Alternative 8B, problems with the top cap of the existing Wickes repository would be eliminated and having only one repository at the Wickes site would result in lower long term inspection and maintenance costs.

#### **4.0 SUMMARY**

Based on the detailed and comparative analysis of the above two additional reclamation alternatives for mine and mill waste from the Frohner Mine and Mill site, the preferred reclamation alternative is alternative 8B. This alternative provides equivalent protection and effectiveness, albeit at a slightly higher construction cost. However, these costs will be somewhat offset due to lower long term inspection and maintenance costs and will also result in a better cap for the existing Wickes repository. The preferred alternative most effectively reclaims the mine site, is easily implementable, provides a high level of protection to human health and the environment, and is cost effective.

#### **REFERENCES**

- GCM Services Inc., (GCM). 1998. "*Cultural Resource Inventory and Assessment for the Frohner Mine and Mill (24JF1560)*" For: Montana Department of Environmental Quality, Mine Waste Cleanup Bureau. October.
- Pioneer Technical Services, Inc. (Pioneer). 2000. "*Expanded Engineering Evaluation and Cost Analysis for the Frohner Miner Site.*" For: Montana Department of Environmental Quality, Mine Waste Cleanup Bureau. December.